

REMARKS

I. Claim Status

Claims 1-9, 11-19, 21, 23 and 24 are pending in the present Application. Claim 1 has been amended, leaving Claims 1-9, 11-19, 21, 23 and 24 for consideration upon entry of the present Amendment. No new matter has been introduced by this amendment. Reconsideration and allowance of the claims are respectfully requested in view of the above amendments and the following remarks.

II. Claim Rejections

a) Under 35 U.S.C. § 103(a)

Claims 1-3, 5-8, 12-13 and 23-24 stand rejected under 35 U.S.C. § 103(a), as allegedly unpatentable over Oshida, et al. (JP Publication 06-056921) herein Oshida in combination with Kurokawa (JP publication 2001-329021), herein.

The Examiner contends that Oshida allegedly discloses a method of manufacturing an inide-substituted polymer comprising the following steps:

1. Reaction of 60-90%wt of aromatic vinyl monomer and 10-40% wt of unsaturated dicarboxylic anhydride, which the Examiner contends, meets the limitation of the instant claim 1 (methyl ethyl ketone at the presence of 0.011%wt initiation). Additionally the Examiner contends that Oshida allegedly discloses that the feeding ration between vinyl and carboxylic acid monomers is best than 5:1 based on their weight asserting that since the molecular weights of the monomers (styrene (104) maleic anhydride (98) and methyl methacrylate (102)) are close the corresponding molar ratio

is less than 6:L1 which allegedly meets the limitation in the instant Claim 1;

2. A separation step performed by supplying the polymerized solution discharged from step 1 into a separation and then removing the unreacted monomers and solvent at 200°C and 50 torr;
3. Reaction of continuously supplying melt from step 2 into the imidization reactor containing aniline and;
4. A Drying step to remove volatiles.

The Examiner states that the limitation in the instant claim 1 regarding the residence time is not disclosed in Oshida as Oshida is a continuous process and not a batch process as claimed. The Examiner states that the advantages of batch processes in that yields are higher, amounts of materials produced may be controlled for economic reasons and that expensive equipment is not required. The Examiner concludes it would have been obvious to establish a batch process with a reaction time to achieve a predetermined conversion of the monomer due to the higher yield in order to make the process more economical. With regards to claim 24 the Examiner contends that Oshida allegedly discloses a weight average molecular weight of 135,000 making note that neither Oshida nor the instant specification allegedly disclose the proper determination of molecular weight by GPC and that by using PS standards with one detection only relative MW can be obtained. The Examiner concludes that since MW figures obtained can differ by up to 20% the MW of Oshida (135,000) and the instant claim 23 (140,700) are indistinguishable.

The Examiner acknowledges that Oshida does not teach that imidization reaction takes place in the presence of a catalyst.

The Examiner contends that Kurokawa disclose a multi step method for the production of imidized polymer where the imidization step takes place in methy isobutyl ketone in the presence of triethylamine with a catalyst increasing the rate of imidization. The Examiner concludes it would have been obvious to use a solvent and a catalyst in the imidization to increase the rate of imidization.

The Examiner acknowledges that Oshida does not teach the conversion of unsaturated carboxylic acid is 95% or more but also contends that Kurokawa allegedly teaches a conversion of unsaturated carboxylic acid that is 95% or more.

The Examiner also contends that Kurokawa allegedly teaches non-polymerized monomer imidizes, degrading the color of the product and therefore its organoleptic quality.

The Examiner concludes it would have been obvious to achieve a weight conversion of the unsaturated carboxylic acid in order to achieve the high quality of the copolymer.

The Examiner further acknowledges that neither Oshida or Kurokawa teach the amount of homopolystyrene. The Examiner contends that Kurokawa allegedly teaches that MWD of the final polymer is between 2 and 3 that is close to the theoretical MWD. The Examiner contends that it suggests that the polymer is unimodal styrene-maleinate copolymer. In contrast the Examiner states in the case of forming vinyl-based homopolymer the resulting MWD would be significantly broader than 3.0. The Examiner further alleges that the instant specification discloses “A reaction temperature in the copolymerization step ranges from 80 to 150 °C, and more preferably 90 to 130°C. If the temperature is lower than 80°C, it may not be possible to obtain the desired molecular weight and a relatively large amount of aromatic vinyl homopolymers, particularly polystyrene, may be generated”.

The Examiner states that Kurokawa allegedly performs a polymerization at 85°C, which is in the lower end of the polymerization temperature disclosed in the instant specification concluding that Kurokawa's polymerization conditions do not favor homopolymer formation.

The Examiner concludes it would have been obvious that it is expected that Kurokawa's polymer has the amount of homopolystyrene at the same or lower level than in the instant specification.

Claims 1, 4, 9, 11 and 14-19, 21, 23 stand rejected under 35 U.S.C. § 103(a), as allegedly unpatentable over Kurokawa (JP publication 2001-329021) in combination with Oshida, et al. (JP Publication 06-056921). The Examiner contends that Kurokawa allegedly discloses a multi step method for the production of imidized polymer where imidization takes place in methyl isobutyl ketone in the presence of triethylamine. The Examiner acknowledges that Kurokawa does not teach the amount of homopolystyrene. The Examiner further states that Kurokawa allegedly teaches that MWD of the final polymer is between 2 and 3, which is close to the theoretical MWD, which is suggestive that the polymer is unimodal styrene-maleinate copolymer. In contrast the Examiner states in the case of forming vinyl based homopolymer the resulting MWD would be significantly broader than 3.0.

The Examiner states that the instant specification discloses "A reaction temperature in the copolymerization step ranges from 80 to 150°C, and more preferably 90 to 130°C. If the temperature is lower than 80°C, it may not be possible to secure a desired conversion and if it exceeds 150°C, it may not be possible to obtain the desired molecular weight and a relatively large amount of aromatic vinyl homopolymers, particularly polystyrene, may be generated".

The Examiner states that it would be obvious that it would be expected that Kurokawa's polymer have the amount of homopolystyrene at the same level or lower than the instant invention. The Examiner states that with regards to claim 4 Kurokawa allegedly discloses 0.001-%wt or initiator which is 1.1 bis(tert-butyl-peroxy) cyclohexane.

Regarding claim 9 the Examiner contends that Kurokawa allegedly teaches 60% wt of methylisobutyl ketone in the first reaction step.

Regarding claim 11 the Examiner contends that Kurokawa allegedly teaches that the reaction temperature in the reactor gradually increases from 85-140°C.

Regarding claim 14 the Examiner contends that Kurokawa allegedly teaches that the molar ratio between maleic anhydride and aniline is within the range of 0.1-0.9.

Regarding claim 15 and 16 the Examiner contends that Kurokawa allegedly teaches that the ratio of triethylamine to aniline is 3/97.

Regarding claims 18 and 19 the Examiner contends that Kurokawa allegedly teaches that imidization takes place at 140°C and devolatilization occurs at 310°C and 30 torr.

The Examiner further asserts that Kurokawa allegedly uses reaction temperatures of 85°C, which reduces the possibility of polystyrene formation.

With regards to claim 21 the Examiner contends that since the Kurokawa reaction conditions are allegedly analogous to the instant application, the Kurokawa process completes at the same time as the instant invention.

The Examiner concludes that it would be obvious that it would be expected that the polymer of Kurokawa would have an amount of homopolystyrene at the same or lower level than the instant invention.

The Examiner also states that Oshida allegedly teaches the aforementioned separation step. The Examiner further states that separation of unreacted monomer and solvent is economically beneficial since they are to be returned into the first step of the process without any additional separation.

The Examiner concludes it would be obvious to include a separation step between the polymerization in the Kurokawa process since it provides an economically sound process due to recycling unreacted monomer and solvent. Applicants respectfully traverse the aforementioned obviousness rejections.

With regards with Oshida the Examiner, it is respectfully, submitted misunderstands that Oshida discloses a polymerization by continuous process, while the present invention discloses a polymerization by batch process.

However, it is clearly understood from the expressions in the instant specification, especially in the examples of this invention that the polymerization according to the present invention is conducted by continuous process. Specifically, the examples express 4.63 L/hr of flow rate and 7.37 L/hr of flow rate and Claim 1 defines adjusting the flow rate of each mixture. These expressions mean that the polymerization of the present invention is performed by a continuous process.

When the polymerization step in Oshida is compared with that of the present invention, Oshida discloses that the polymerization is conducted at 150°C of the polymerization temperature until the polymerization conversion ratio becomes 65% (See [0021] paragraph). Therefore, Oshida does not meet with the limitation of Claim 1 that the polymerization conversion ratio of unsaturated dicarboxylic acid anhydride shall be 95% or more.

Also, the reaction temperature according to the present invention is 80-150°C and the polymerization continues until the polymerization conversion ratio of unsaturated dicarboxylic acid anhydride becomes 95% or more so that the reaction time may be 2-5 hours, while Oshida's reaction time would be very less than that of the present invention because the polymerization reaction in Oshida is conducted at a temperature higher than that of the present invention only until the conversion ration (65%) lower than that of the present invention. Therefore, Oshida also does not meet with the limitation of Claim 1 for the reaction time.

From these facts, we can understand that Oshida does not teach or suggest the core of the technical concept and idea in the polymerization of the present invention. That is to say, the present invention is accomplished concurrently to achieve the purpose that the homopolystyrene, for example, shall not be generated in the polymerization step and for the purpose that 95% or more of conversion ratio of the unsaturated dicarboxylic acid anhydride shall be achieved in a short reaction time to obtain economical advantages. These technical features are difficult to achieve together. In order to achieve the purposes concurrently, the present invention is to control the temperature, the mixing rate (flow rate) of reactant mixtures and reaction time so that the aromatic vinyl monomer and the unsaturated dicarboxylic acid anhydride, which are different in reaction rate from each other, may be polymerized with an appropriate reaction rate and ratio. For example, in case that the reaction time is too long (as in Comparative Example 3 of this application), the polymerization conversion ratio becomes higher, but the amount of homopolymer generated in the step also becomes higher so that the purpose for thermal durability may not be achieved. In case that the reaction time is too short as in Oshida, a large amount of energy will be used for the recovery of the unreacted monomers so that this method becomes uneconomical.

Oshida would recognize that both of the purposes contrary to each other could not be achieved concurrently and would focus the advantage of the continuous process only to achieve the short reaction time and prevention of homopolystyrene formation. Therefore, Oshida has the disadvantages of low polymerization ratio and large amount of energy in the recovery of the unreacted monomers. That is to say, Oshida did not achieve the compromise between the prevention of homopolymer formation in an appropriately short reaction time and the high conversion ratio, while the present invention achieves the compromise.

Oshida is common with the present invention in comprising the separation step of the unreacted monomers, but distinctly different from the present invention in that the unsaturated dicarboxylic acid anhydride monomer as well as the aromatic vinyl monomer remains in a large amount of unreacted state due to the low polymerization conversion ratio in Oshida and thus a large amount of energy is used for the recovery of the unreacted monomers.

Also, the imidization process of Oshida is different from that of the present invention in that the imidization is conducted in a very short time (2-5 minutes) at a very severe condition (high temperature, pressure and shear rate) in an extruder, as described in the specification of this application.

In addition to this, Oshida is to conduct the imidization process in a separate extruder after preparing pellets from the polymer obtained from the separation process, as seen in its embodiments. That is to say, Oshida is not to conduct the continuous process consisting of the polymerization, separation and imidization. This may affect the whole process efficiency. Contrary to this, the present invention is continuously to conduct the imidization in such a way that the polymer melt discharged continuously from the separator is fed into the imidization reactor.

With regards to Kurokawa applicants contend that Kurokawa's invention relates to a method of preparing imidized copolymer in a continuous manner comprising the steps of polymerizing monomers mixture including an aromatic vinyl monomer and an unsaturated dicarboxylic acid anhydride in a continuous multi-step manner, conducting imidization reaction in a continuous multi-step manner, and continuously volatilizing the solvent.

The purpose of Kurokawa is to prepare the imidized copolymer with good thermal stability and color tone in such a way of high polymerization conversion ratio ([0004] paragraph). This purpose is achieved by the continuous multi-step manner of polymerization and imidization, especially, the continuous multi-step manner of polymerization allows a uniform composition of copolymer in such a way that each of the monomers is polymerized with high conversion ratio. Kurokawa explains that when each of the monomers is polymerized in less than 95% of conversion ratio, the unreacted monomers operates in the imidization process largely to deteriorate the color tone of the final imidized copolymer ([0008] paragraph).

In more detail, Table 1 in the specification of Kurokawa shows that all the Examples of Kurokawa has 95% or more of polymerization conversion ratios of styrene monomer and maleic acid anhydride and that the differences between the conversion ratios of the monomers are very small. On the contrary, in an example (Comparative Example 1) of polymerization in single-step manner, not in the multi-step manner, the conversion ratio of styrene is 44.5% and the conversion ratio of maleic acid anhydride is 52.4%, and the differences between the conversion ratios of the monomers are very considerable. Kurokawa explains that if the polymerization is performed in the single-step manner, not the multi-step manner, then the polymerization conversion ratio and imidization ratio decrease, the value of YI and the amount of the total volatile components increase, and the thermal stability of the final copolymer deteriorates ([0032] paragraph). In an example (Comparative Example 2) of polymerization in a manner of batch reaction after maleic

acid anhydride solution is added into styrene solution for 10 hours, all the polymerization conversion ratios of styrene and maleic acid anhydride becomes 95% or more, but it takes too long to obtain the product and the YI value of the product becomes high to deteriorate the color tone ([0032] paragraph).

It is understood from these observations that the principle in Kurokawa is completely different from that in the present invention. In Comparative Example 1 (a polymerization method in single-step manner) in Kurokawa, the ratio by weight of styrene/maleic acid anhydride. Usually the reaction rate of maleic acid anhydride is faster than that of styrene. Therefore, as seen in Table 1, the conversion ration of styrene is considerably lower than that of maleic acid anhydride, even though the composition ratio of styrene in the final product is larger than that of maleic acid anhydride. This unbalance due to the difference of reaction rate could be solved by a batch type polymerization (Comparative Example 2), but could not be solved by a general continuous process (polymerization in single-step manner). Therefore, Kurokawa solves this unbalance by means of the process in multi-step manner. Please pay attention to the fact that the polymerization conversion ratio of styrene in the Examples of Kurokawa is almost same as that of maleic acid anhydride, which is greatly faster in reaction rate than styrene.

By the way, in order more clearly to distinguish Claim 1 from Kurokawa in view of this difference, Claim 1 further includes the limitation “the conversion of the aromatic vinyl monomer is in the range of 67-85 wt%.” Such a limitation is approvable from the suggestions contained in the Examples of the instant specification (the minimum value: 67.2%, the maximum value: 85.3% and several of the meddle values).

Next, Kurokawa directly conducts the imidization process without separation of the unreacted monomers and solvent. As discussed above, this teaches that the separation process is not necessary because the polymerization process in the multi-step manner allows the monomers to be mostly polymerized. Contrary to this, in the present invention, maleic acid anhydride is mostly polymerized so that it may not necessary to recover the maleic acid anhydride in the

separation process, but styrene considerably remains in unreacted state. If the remained styrene is not recovered, then it badly affects the imidization reaction. It is same case as in Oshida.

Accordingly, it can be understood that the principles of the present invention and Kurokawa are completely different from each other even in view of this point, and Kurokawa is not compatible to the present invention and also Oshida.

The Examiner alleges that Claim 1 is obvious over the combination of Oshida and Kurokawa, because all the limitations in Claim 1 are partly disclosed in Oshida and in Kurokawa. However, as observed above, Kurokawa is to conduct the polymerization by multi-step continuous process, while Oshida is to do it by single-step continuous process, so both processes are not compatible to each other. As shown above, Kurokawa think out the multi-step continuous process in order to solve the problem of the single-step continuous process, therefore, it is clear by itself that the conditions applicable to the multi-step continuous process are not applicable to the single-step continuous process.

Claim 1 is therefore not obvious over Oshida and Kurokawa alone or in combination. Applicant's respectfully request reconsideration and withdrawal of these rejections.

III. Conclusion

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable to Applicants. Accordingly, reconsideration and allowance are requested.

If there are any additional charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130.

Respectfully submitted,
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